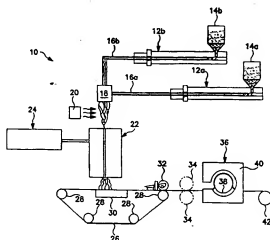




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(54) Title: CRIMPED MULTICOMPONENT FILAMENTS AND SPUNBOND WEBS MADE THEREFROM



## (57) Abstract

Spunbond multicomponent filaments and nonwoven webs made from the filaments are disclosed. In accordance with the present invention, the multicomponent filaments contain a crimp enhancement additive. Specifically, the crimp enhancement additive is added to the polymeric component that has the slower solidification rate. The additive enhances crimp, allows for highly crimped filaments to be made at low fiber linear densities, improves the integrity of unbonded webs made from the filaments, and produces webs with improved stretch and cloth-like properties. The additive incorporated into the filaments is a random copolymer of butylene and propylene.

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## CRIMPED MULTICOMPONENT FILAMENTS AND SPUNBOND WEBS MADE THEREFROM

10

**Technical Field**

15 The invention relates in general to wireless communications system infrastructure, and more particularly to wireless communications systems offering packet data service to mobile stations.

**Background**

20 Mobile data communications is rapidly becoming one of the fastest growing segments of the mobile communications market. A strong driving force is the fast growing portable computing market and the need for flexible wireless data communications it creates. This market force is further emphasized by the smaller, more personal oriented computing devices, such as Personal Digital Assistants (PDAs), and other so called  
25 palm top computing devices. With PDAs and other such personal computing devices, as well as with more conventional portable computers, it is possible to send and receive electronic mail, facsimiles, and even browse public information networks such as the world wide web. As these activities become popular for mobile equipment users, so too will the  
30 demand for mobile wireless data services.

At the same time, other types of mobile communications services are also in increased demand. These other services include mobile telephone interconnect service, such as cellular telephone, and dispatch radio service, for example. Typically these types of services are provided  
35 with separate equipment. That is, traditionally, dispatch and telephone interconnect systems have been separate systems, each requiring fixed and mobile equipment. However, there has been a move underway to provide

multiple communications services to mobile users using common mobile and fixed equipment. These are the so called integrated services radio networks, an excellent example of which is found in U.S. patent No.

5 5,548,631 to Krebs et al. These systems use digital modulation for the radio channel, and are typically time divisioned to allow multiple channels on a single frequency or pair of frequencies.

Mobile data service, or packet data, as it is sometimes referred, has been added to cellular telephone service such as GSM. An example of which can be found in U.S. patent No. 5,590,133 to Billström et al.

10 However, to date, packet data service has not been made available commercially in integrated services radio networks. In doing so, a number of problems are presented, and chief among these is the registration of mobile subscriber units or mobile stations for packet data service.

In a typical communications equipment network a subscriber data  
15 base is maintained that includes provisioning information, feature activation status, and so forth. This database is typically referred to as a home location register (HLR), and is well understood. Upon receiving a request for registration from a mobile station, the network equipment will access the HLR, find the correlating subscriber record, and determine what  
20 features to activate for the mobile station, as well as the necessary authentication information, among other pertinent information. This information is transferred to another database called the visit location register (VLR), which is also well understood in the art. The VLR is used by the system to also track the location in the system of the mobile station.  
25 That is, what particular cell or cells the mobile station was most recently in, so that an incoming call may be routed correctly.

In adding any service such as packet data service to a communications network, a VLR function is also necessary to track mobile stations within the serving area. This will allow the system to, for  
30 example, send notifiers that the system has received email for the mobile station. Therefore, there is a need, in an integrated services radio system, for a means by which a mobile station can register for packet data service, and for a means by which the serving equipment can track the mobile station.

### Brief Description Of The Drawings

FIG. 1 shows a block diagram of a general integrated services radio system in accordance with the invention;

5 FIG. 2 shows a more detailed block diagram of an integrated services radio system in accordance with the invention; and

FIG. 3 shows a signaling diagram of a registration process in accordance with the invention.

### Detailed Description Of The Preferred Embodiment

10 While the specification concludes with claims defining the features of the invention that are regarded as novel, it is believed that the invention will be better understood from a consideration of the following description in conjunction with the drawing figures, in which like reference numerals are carried forward.

15 Whenever new services are added to existing mobile communications services, there is a problem in that care must be taken to insure that mobile station's locations within the serving area are known. This must initially be set up during registration of each mobile subscriber. As mobile stations change cells during service use, the system must be able  
20 to track the mobile station. To avoid unnecessary system complexity, it is desirable that the equipment responsible for providing the service have a means for tracking a mobile station's location. Herein such a system and means are described. Specifically, a multi-tiered visit location register approach is used, wherein a home location register provides a subscriber  
25 record to a first entity, and upon request, the first entity provides the same information to a second entity. In the preferred embodiment, the first entity is a dispatch control processor and the third entity is a mobile data gateway for providing packet data service to mobile station.

Referring now to FIG. 1, which shows a block diagram of a general  
30 integrated services radio system in accordance with the invention. In the preferred embodiment, the system provides at least telephone interconnect service and dispatch voice service, as well as packet data service. Telephone interconnect service is provided in a manner similar to GSM cellular, as is well known in the art. A mobile switching center (MSC) 100  
35 is connected to a public switched telephone network 102 and a plurality of base site controllers (BSC), such as base site controller 104. Each base site

controller is operably coupled to a plurality of transceiver sites (TS) 106, preferably by an ethernet bus 108. The transceiver sites contain radio transmitters and receivers configured to communicate with mobile stations, such as mobile station 110, on channels that are defined in frequency and in time, such as with time division multiple access (TDMA) and time division multiplex (TDM) schemes. In general, the mobile stations are typically either hand held radio devices, or automobile mounted radio devices, as with cellular telephone equipment.

To provide dispatch voice service, a dispatch control processor (DCP) 112 is provided. The DCP comprises equipment and resources for processing dispatch requests, such as a dispatch applications processor (DAP) 113, and equipment for duplicating and transmitting voice packets to various parts of the network, such as a metropolitan packet switch (MPS) 114, to allow a user to communicate with an individual user or selected group of users in a dispatch mode. The DCP is operably coupled to the transceiver sites to send and receive traffic and control data over the network.

To providing packet data service, a mobile data gateway (MDG) 116 is provided. The MDG is operably coupled to a wide area packet network (WAPN) 118, such as the public internet, through a routing network 120. The routers exchange and route data with the WAPN in a conventional manner. The MDG is operably coupled to the transceiver sites, and communicates with the mobile stations by using, for example, mobile internet protocol. In this manner, packet data is communicated between the mobile station and the WAPN. The mobile station may either be the user of the service, as when retrieving and displaying email text messages, or may act as a data modem for another computing device, such as a portable computer 122.

Prior to providing any service to a mobile station, the system must first verify and authenticate the mobile station. This process is known in the art as registration. To facilitate registration, it is necessary that a record correlating to the mobile station be kept. Such records are typically stored in a non-volatile database referred to as a home location register (HLR) 124. In a typical registration process the mobile station first scans the airwaves to find a control channel, over which system and location specific information is broadcast. The mobile station then sends a request to

register to the appropriate network entity. For telephone interconnect service, for example, the request is sent to the MSC. Upon receiving the request, the MSC obtains the record for the mobile station from the HLR. The record is stored in a visit location register (VLR), as is well known in the art, and the VLR record is further used to update location information of the mobile station. Upon successfully authenticating the mobile station, telephone interconnect service is then provided. For dispatch registration, the process is very similar. The mobile station sends a request to register to the DAP 113, which then obtains the mobile subscriber's record from the HLR. The DCP has a visit location register as well, and is referred to as a D-VLR 126. The D-VLR functions and serves the same purpose as in the MSC.

In providing packet data service, it is also necessary for a mobile station to register, and for the system to keep a record of the mobile stations location as it changes location within the serving area of the system. In the preferred embodiment, the mobile station first registers for dispatch service. The DAP, once it receives the mobile station's record from the HLR, passes information to the MDG. In a sense, the D-VLR acts as an HLR to the MDG. The MDG then retains the information locally.

Referring now to FIG. 2, there is shown a more detailed block diagram of an integrated services radio system in accordance with the invention. This diagram offers a more practical system view. In a system serving large metropolitan regions, there will be multiple network entities at all levels to provide the necessary capacity capability. For example, in this diagram there is a plurality of dispatch application processors, each with it's own D-VLR 126. Coupled to each DAP there will likely be a plurality of mobile data gateways 116. By providing multiple MDGs, the system owner can offer higher capacity data transmission, commonly referred to as bandwidth. In practice, upon successfully registering for packet data service, the DAP will select and assign a MDG to serve the mobile station. In that way, the data traffic load can be balanced between the MDGs. Each MDG is connected to all of the transmitter sites 106 in the serving area, preferably through an access controller gateway 200. Thus, the invention provides for a two tiered VLR configuration; the MDG operates with the D-VLR similarly to how the D-VLR operates with the HLR.

In operating a mobile communications system, there are many events that may occur relating to the registration process. The following examples serve to illustrate how the invention operates under specific conditions. First, when a mobile subscriber needs to be authenticated, the D-VLR requests the appropriate authentication sets from the HLR. The HLR returns them, and includes an encryption key, as is known in the art. The D-VLR then passes the encryption key to the MDG. The encryption key is used by the MDG to perform over the air encryption of the data it transmits to the mobile station, and the mobile station may do the same in transmitting data to the MDG. Second, in retrieving the necessary information to register a mobile station in a new serving area, the new D-VLR indicates the change to the HLR, and the HLR returns the subscriber record for retention at the new D-VLR, which then passes the change to the MDG serving the mobile station. Third, changes to subscriber records, such as those made by craftpersons, are made at the HLR. Any such changes propagate from the HLR to the D-VLR to the MDG. In other words, the change triggers the HLR to communicate to the D-VLR, and indicate the change, and the D-VLR does the same with the MDG. Fourth: traditionally the D-VLR stores subscriber records in a volatile storage means, such as a RAM. However, as the D-VLR acts as an HLR to the MDG, it is important that non-volatile storage is provided, such as a hard disk drive. This provides a measure of protection should the MDG need to recover the information for any reason. Additionally, by providing the D-VLR with a non-volatile memory means, it can be used to backup state information of the MDGs, and the state of the data that the HLR contains to mediate data deviations between the MDG and the HLR.

Referring now to FIG. 3, there is shown a signaling diagram of a registration process in accordance with the invention. The method includes first beginning with the mobile station (MS) sending a request to register 300 to the DAP/D-VLR. Then the D-VLR requests information 302, known as the subscriber record, from the HLR, the information includes authentication information and feature information. The authentication information is used to authenticate the mobile station, as is known in the art, and the feature information is used to determine what features and services the mobile station is granted by the system. The feature information will indicate if the mobile station may engage in packet data



service, for example. The HLR then transfers the subscriber record 304 to the D-VLR. The DAP uses the authentication information to authenticate the mobile station 306. In the preferred embodiment, after this step, a messaging session between the DAP and the HLR occurs in accordance with GSM specifications, and includes messages such as UPDATE\_LOCATION, and acknowledgments. Upon successfully authenticating the mobile station, the DAP selects an MDG to service the mobile station, and the D-VLR passes 308 location information and, optionally, an encryption key code to the selected MDG. This step may be performed either automatically by the system, or in response to the mobile station requesting additional services, such as packet data. The DAP then grants 310 system access to the mobile station, and in so doing, passes the necessary channel and network information to the mobile station. Finally, the mobile station engages 312 the MDG in a packet data communication. In the preferred embodiment, the mobile station, after successfully registering for dispatch service, requests registration for packet data service, which triggers the DAP to transfer the necessary subscriber record to the MDG.

In summary, the preferred method includes the steps of: registering for a first service, the first service being provided by a first network entity having a VLR; sending a request to register for the additional service, the additional service provided by a second network entity operably coupled to the first network entity; transferring a subscriber record from the first network entity to the second network entity; and establishing service between the mobile station and the second network entity. In the preferred embodiment, the steps become: sending a request to register for packet data service from the mobile subscriber to the dispatch application processor; transferring a subscriber record corresponding to the mobile subscriber from a home location register to a visit location register operably connected to the dispatch applications processor; selecting a mobile data gateway to service the mobile subscriber, performed by the dispatch application processor; transferring the subscriber record corresponding to the mobile subscriber from the visit location register to the mobile data gateway; and establishing a packet data link between the mobile subscriber and the mobile data gateway in accordance with the subscriber record.

Thus, the invention provides a communications system providing multiple communications service with a method and apparatus for providing subscriber data for another service's registration of a mobile station. In the preferred embodiment, a method of registering a mobile  
5 subscriber for a packet data service was discussed. Specifically, there is provided a two tiered VLR scheme where one VLR, the D-VLR acts as conventional VLR to a conventional HLR, and as an HLR to a network entity, such as a mobile data gateway (MDG), for example. This arrangement allows the MDG to send incoming packet data packets to the  
10 correct transceiver site for transmission to the mobile station without having to request the information from a HLR. Although a packet data service has been shown in the preferred embodiment, it is contemplated that the multi-tiered VLR scheme can be used for many over-laid network services, examples of which include location tracking equipment for  
15 tracking a mobile stations location within a cell. While the preferred embodiments of the invention have been illustrated and described, it will be clear that the invention is not so limited. Numerous modifications, changes, variations, substitutions and equivalents will occur to those skilled in the art without departing from the spirit and scope of the present  
20 invention as defined by the appended claims.

What is claimed is:

## CLAIMS

1. A method of registering a mobile station for an additional service in a mobile communications system providing multiple services, the  
5 method comprising the steps of:

registering for a first service, the first service being provided by a first network entity having a VLR;

10 sending a request to register for the additional service, the additional service provided by a second network entity operably couple to the first network entity;

transferring a subscriber record from the first network entity to the second network entity; and

15 establishing service between the mobile station and the second network entity.

2. The method of claim 1, wherein the step of registering for a first service is registering for dispatch service.

20 3. The method of claim 1, wherein the step of registering for the additional service is registering for packet data service.

4. The method of claim 1, wherein the step of transferring is transferring from a dispatch visit location register to a mobile data gateway.

25 5. The method of claim 1, wherein the step of establishing is establishing a packet data service.

6. A method of registering a mobile station for packet data service, the method comprising the steps of:

transferring a subscriber record corresponding to the mobile subscriber from a home location register to a visit location register operably

5 connected to the dispatch applications processor;

selecting a mobile data gateway to service the mobile subscriber, performed by the dispatch application processor;

transferring the subscriber record corresponding to the mobile subscriber from the visit location register to the mobile data gateway; and

10 establishing a packet data link between the mobile subscriber and the mobile data gateway in accordance with the subscriber record.

7. A method as in claim 6, further comprising the step of sending a request to register for packet data service from the mobile subscriber to the dispatch application processor prior to performing the step of transferring a

15 subscriber record from a home location register to a visit location register.

8. A mobile communications systems for providing multiple services, comprising:

a home location register for storing a plurality of subscriber records;

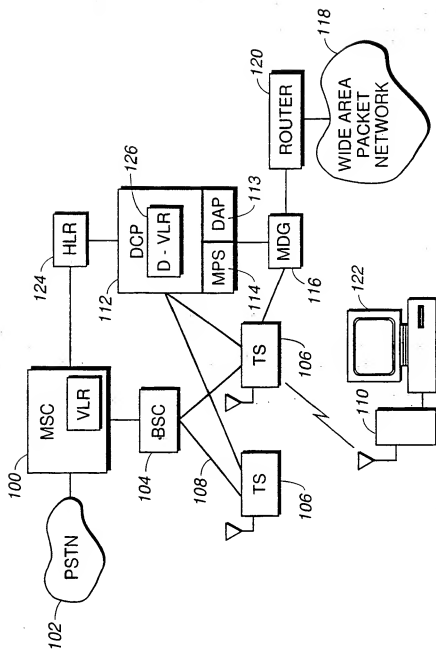
5 a first network entity for providing a first communications service operably coupled to the home location register and having a storage means for storing a plurality of subscriber records; and

a second network entity for providing a second communications service operably coupled to the first network entity and having a means for storing a plurality of subscriber records.

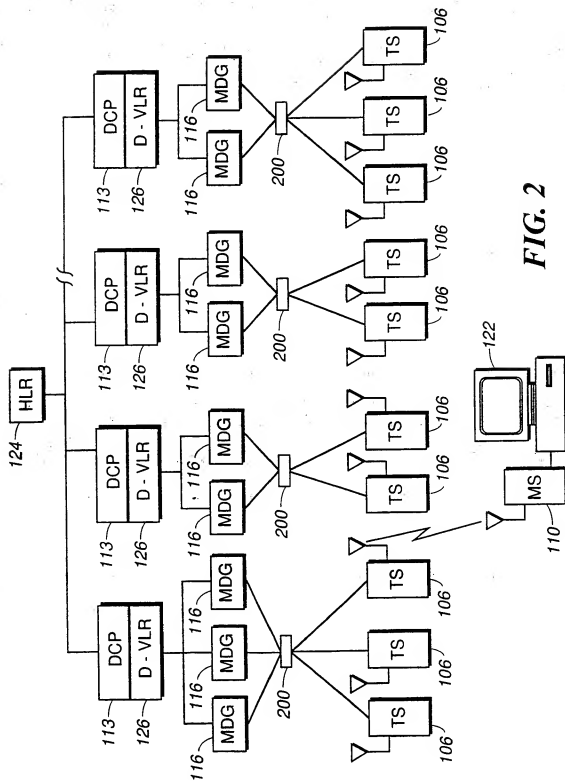
10 9. A mobile communications service as in claim 8, wherein the first network entity is a dispatch control processor.

15 10. A mobile communications service as in claim 8, wherein the second network entity is a mobile data gateway.

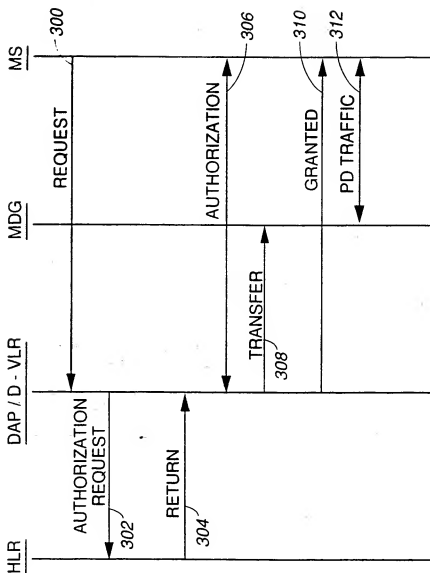
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**FIG. 1**

*2/3*



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**FIG. 3**



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 98/20539

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 D01F8/06 D02G1/18 D02G3/04

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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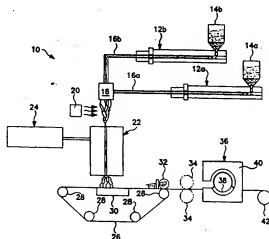
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(54) Title: **CRIMPED MULTICOMPONENT FILAMENTS AND SPUNBOND WEBS MADE THEREFROM**



(57) Abstract

Spunbond multicomponent filaments and nonwoven webs made from the filaments are disclosed. In accordance with the present invention, the multicomponent filaments contain a crimp enhancement additive. Specifically, the crimp enhancement additive is added to the polymeric component that has the slower solidification rate. The additive enhances crimp, allows for highly crimped filaments to be made at low fiber linear densities, improves the integrity of unbonded webs made from the filaments, and produces webs with improved stretch and cloth-like properties. The additive incorporated into the filaments is a random copolymer of butylene and propylene.

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CRIMPED MULTICOMPONENT FILAMENTS  
AND SPUNBOND WEBS MADE THEREFROM

Field of the Invention

The present invention is generally directed to spunbond multicomponent filaments and to nonwoven webs made from the filaments. More particularly, the present invention is directed to incorporating an additive into one of the polymers used to make multicomponent filaments. The additive enhances crimp, allows for finer filaments, improves the integrity of unbonded webs made from the filaments, enhances bonding of the filaments, and produces webs with improved stretch and cloth-like properties. The additive incorporated into the filaments is a butylene-propylene random copolymer.

Background of the Invention

Nonwoven fabrics are used to make a variety of products which desirably have particular levels of softness, strength, uniformity, liquid handling properties such as absorbency, and other physical properties. Such products include towels, industrial wipers, incontinence products, filter products, infant care products such as baby diapers, absorbent feminine care products, and garments such as medical apparel. These products are often made with multiple layers of nonwoven fabrics to obtain the desired combination of properties. For example, disposable baby diapers made from polymeric nonwoven fabrics may include a soft and porous liner layer which fits next to the baby's skin, an impervious outer cover layer which

is strong and soft, and one or more interior liquid handling layers which are soft, bulky and absorbent.

Nonwoven fabrics such as the foregoing are commonly made by melt spinning thermoplastic materials. Such fabrics are called spunbond materials. Spunbond nonwoven polymeric webs are typically made from thermoplastic materials by extruding the thermoplastic material through a spinneret and drawing the extruded material into filaments with a stream of high velocity air to form a random web on a collecting surface.

Spunbond materials with desirable combinations of physical properties, especially combinations of softness, strength and absorbency, have been produced, but limitations have been encountered. For example, for some applications, polymeric materials such as polypropylene may have a desirable level of strength but not a desirable level of softness. On the other hand, materials such as polyethylene may, in some cases, have a desirable level of softness but not a desirable level of strength.

In an effort to produce nonwoven materials having desirable combinations of physical properties, nonwoven polymeric fabrics made from multicomponent or bicomponent filaments and fibers have been developed. Bicomponent or multicomponent polymeric fibers or filaments include two or more polymeric components which remain distinct. As used herein, filaments mean continuous strands of



material and fibers mean cut or discontinuous strands having a definite length. The first and subsequent components of multicomponent filaments are arranged in substantially distinct zones across the cross-section of the filaments and extend continuously along the length of the filaments. Typically, one component exhibits different properties than the other so that the filaments exhibit properties of the two components. For example, one component may be polypropylene which is relatively strong and the other component may be polyethylene which is relatively soft. The end result is a strong yet soft nonwoven fabric.

To increase the bulk or fullness of the bicomponent nonwoven webs for improved fluid management performance or for enhanced "cloth-like" feel of the webs, the bicomponent filaments or fibers are often crimped. Bicomponent filaments may be either mechanically crimped or, if the appropriate polymers are used, naturally crimped. As used herein, a naturally crimped filament is a filament that is crimped by activating a latent crimp contained in the filaments. For instance, in one embodiment, filaments can be naturally crimped by subjecting the filaments to a gas, such as a heated gas, after being drawn.

In general, it is far more preferable to construct filaments that can be naturally crimped as opposed to having to crimp the filaments in a separate mechanical process. Difficulties have been experienced in the past, however, in producing

filaments that will crimp naturally to the extent required for the particular application. Also, it has been found to be very difficult to produce naturally crimped fine filaments, such as filaments having a linear density of less than 2 denier. Specifically, the draw force used to produce fine filaments usually prevents or removes any meaningful latent crimp that may be contained in the filaments. As such, currently a need exists for a method of producing multicomponent filaments with enhanced natural crimp properties. Also, a need exists for nonwoven webs made from such filaments.

#### Summary of the Invention

The present invention recognizes and addresses the foregoing disadvantages, and others of prior art constructions and methods.

Accordingly, an object of the present invention is to provide improved nonwoven fabrics and methods for making the same.

Another object of the present invention is to provide nonwoven polymeric fabrics including highly crimped filaments and methods for economically making the same.

A further object of the present invention is to provide a method for controlling the properties of a nonwoven polymeric fabric by varying the degree of crimp of filaments and fibers used to make the fabric.

Another object of the present invention is to provide an improved process for naturally crimping multicomponent filaments.

It is another object of the present invention to provide a method for naturally crimping multicomponent filaments by adding to one of the components of the filaments a butylene-propylene copolymer.

Still another object of the present invention is to provide a naturally crimped filament that has a linear density of less than 2 denier.

Another object of the present invention is to provide a bicomponent filament made from polypropylene and polyethylene, wherein a crimp enhancement additive has been added to the polyethylene.

It is still another object of the present invention to provide a process for naturally crimping multicomponent filaments containing polypropylene and polyethylene in which a crimp enhancement additive and reclaimed polymer has been added to the polyethylene.

Another object of the present invention is to provide a crimp enhancement additive that also improves the strength of unbonded webs made from filaments containing the additive.

These and other objects of the present invention are achieved by providing a process for forming a nonwoven web. The process includes the steps of melt spinning multicomponent filaments. The multicomponent filaments include a first

polymeric component and a second polymeric component. The first polymeric component has a faster solidification rate than the second polymeric component for providing the filaments with a latent crimp. The second polymeric component contains a crimp enhancement additive that is a butylene-propylene copolymer.

Once melt spun, the multicomponent filaments are drawn and naturally crimped. Thereafter, the multicomponent crimped filaments are formed into a nonwoven web for use in various applications.

In one embodiment, the second polymeric component can include polyethylene. The butylene-propylene copolymer can be added to the second polymeric component in an amount less than about 10% by weight, and particularly from about 0.5% to about 5% by weight. Preferably, the butylene-propylene copolymer is a random copolymer containing less than about 20% by weight butylene, and particularly about 14% by weight butylene.

The first polymeric component, on the other hand, in one preferred embodiment is polypropylene. Other polymers that may be used include nylon, polyester and copolymers of polypropylene, such as a propylene-ethylene copolymer.

In accordance with the present invention, it has been also discovered that the butylene-propylene copolymer also functions as a polymer compatibilizer. In particular, it has been found that the copolymer allows better homogeneous mixing between different polymers. In this regard, the

first polymeric component, in accordance with the present invention, can also contain reclaim polymer. Reclaim polymer, as used herein, are polymer scraps that are recycled and added to the filaments. For instance, the reclaim polymer can comprise a mixture of polyethylene, polypropylene, and copolymers of propylene and ethylene, and can be obtained from the trimmed edges of previously formed nonwoven webs. In the past, difficulties were experienced in recycling reclaim polymer, especially bicomponent reclaim polymer, and incorporating them into filaments without adversely affecting the physical properties of the filaments.

These and other objects of the present invention are also achieved by providing a nonwoven web made from spunbond multicomponent, crimped filaments. The multicomponent crimped filaments are made from at least a first polymeric component and a second polymeric component. In particular, the polymeric components are selected such that the first polymeric component has a faster solidification rate than the second polymeric component. In accordance with the present invention, the second polymeric component contains a crimp enhancement additive. Specifically, the crimp enhancement additive is a butylene-propylene random copolymer.

For instance, in one embodiment, the crimped filaments can be bicomponent filaments which include a polypropylene component and a polyethylene component. The butylene-propylene

random copolymer can be added to the polyethylene component in an amount up to about 5% by weight. Preferably, the butylene-propylene random copolymer contains about 14% by weight butylene.

5           Because of the addition of the crimp enhancement additive, the multicomponent filaments can have a very low denier and still be crimped naturally. For instance, the denier of the filaments can be less than 2, and particularly less  
10           than about 1.2.

          In this regard, the present invention is also directed to a naturally crimped multicomponent filament that includes at least a first polymeric component and a second polymeric component. The  
15           first polymeric component can be, for instance, polypropylene. The second polymeric component, on the other hand, can be, for instance, polyethylene and can contain a crimp enhancement additive in an amount sufficient to allow the filaments to be  
20           naturally crimped at a denier of less than about 2 and particularly less than about 1.2.

          Other objects, features and aspects of the present invention are discussed in greater detail below.

#### 25           Brief Description of the Drawings

          A full and enabling disclosure of the present invention, including the best mode thereof, to one of ordinary skill in the art, is set forth more particularly in the remainder of the specification,  
30           including reference to the accompanying figures, in which:

FIG. 1 is a schematic drawing of a process line for making a preferred embodiment of the present invention;

FIG. 2A is a schematic drawing illustrating the cross section of a filament made according to an embodiment of the present invention with the polymer components A and B in a side-by-side arrangement; and

FIG. 2B is a schematic drawing illustrating the cross section of a filament made according to an embodiment of the present invention with the polymer components A and B in a eccentric sheath/core arrangement.

Repeat use of reference characters in the present specification and drawings is intended to represent same or analogous features or elements of the invention.

#### Detailed Description of Preferred Embodiments

It is to be understood by one of ordinary skill in the art that the present discussion is a description of exemplary embodiments only, and is not intended as limiting the broader aspects of the present invention, which broader aspects are embodied in the exemplary construction.

The present invention is generally directed to multicomponent filaments and to spunbond webs produced from the filaments. In particular, the filaments are naturally crimped into, for instance, a helical arrangement. Crimping the filaments increases the bulk, the softness, and the drapability. The nonwoven webs also have improved

fluid management properties and have an enhanced cloth-like appearance and feel.

Multicomponent filaments for use in the present invention contain at least two polymeric components. The polymeric components can be, for instance, in a side-by-side configuration or in an eccentric sheath-core configuration. The polymeric components are selected from semi-crystalline and crystalline thermoplastic polymers which have different solidification rates with respect to each other in order for the filaments to undergo natural crimping. More particularly, one of the polymeric components has a faster solidifying rate than the other polymeric component.

As used herein, the solidification rate of a polymer refers to the rate at which a softened or melted polymer hardens and forms a fixed structure. It is believed that the solidification rate of a polymer is influenced by different parameters including the melting temperature and the rate of crystallization of the polymer. For instance, a fast solidifying polymer typically has a melting point that is about 10° C or higher, more desirably about 20° C or higher, and most desirably about 30° C or higher than a polymer that has a slower solidifying rate. It should be understood, however, that both polymeric components may have similar melting points if their crystallization rates are measurably different.

Although unknown, it is believed that the latent crimpability of multicomponent filaments is



created in the filaments due to the differences in the shrinkage properties between the polymeric components. Further, it is believed that the main cause of the shrinkage difference between polymeric components is the incomplete crystallization of the slower solidifying polymer during the fiber production process. For instance, during formation of the filaments, when the fast solidifying polymer is solidified, the slow solidifying polymer is partially solidified and does not measurably draw any longer and thus does not further experience a significant orienting force. In the absence of an orienting force, the slow solidified polymer does not significantly further crystallize while being cooled and solidified. Accordingly, the resulting filaments possess latent crimpability, and such latent crimpability can be activated by subjecting the filaments to a process that allows sufficient molecular movement of the polymer molecules of the slow solidifying polymer to facilitate further crystallization and shrinkage.

The present invention is directed to adding a crimp enhancement additive to the polymeric component having the slower solidification rate in order to further slow the solidification rate of the polymer. In this manner, the differences between the solidification rates of both polymeric components becomes even greater creating multicomponent filaments that have an enhanced latent crimpability. In particular, the crimp

enhancement additive of the present invention is a random butylene-propylene copolymer.

Besides creating multicomponent filaments that have a greater natural crimp, it has also been

5 discovered that the crimp enhancement additive of the present invention provides many other benefits and advantages. For instance, because the

10 filaments of the present invention have a greater degree of crimping, fabrics and webs made from the filaments have a higher bulk and a lower density.

By being able to make lower density webs, less material is needed to make webs of a specified thickness and the webs are thus less expensive to produce. Besides having lower densities, the webs  
15 have also been found to be more cloth-like, to have a softer hand, to have more stretch, to have better recovery, and to have better abrasion resistance.

Of particular advantage, it has also been unexpectedly discovered that the crimp enhancement  
20 additive of the present invention further improves the strength and integrity of unbonded webs made from the filaments. For instance, it was discovered that adding only 1% by weight of the  
25 additive can more than double the unbonded strength of the web. By having greater unbonded web integrity, the webs of the present invention may be processed at faster speeds. In the past, in order to run at higher speeds, unbonded spunbond webs had to be prebonded or compacted. Such steps are not  
30 necessary when processing webs made according to the present invention.

Besides have increased strength, spunbond webs made according to the present invention also have dramatically reduced web handling problems when processed at higher speeds. For instance, the occurrences of eyebrows, flip overs and stretch marks are significantly reduced when the crimp enhancement additive is present within the filaments. More particularly, webs incorporating filaments made according to the present invention have a lesser tendency to protrude from the web but, instead, have a greater tendency to lay down on the web surface. As such, the filaments are less likely to penetrate the foraminous surface upon which the web is formed, thus making it easier to remove the web from the surface.

Another unexpected benefit to using the crimp enhancement additive of the present invention is that the additive also functions as polymer compatibilizer. In other words, the additive facilitates homogeneous mixing of different polymers. Thus, the polymeric component containing the additive can contain a mixture of polymers if desired. For example, in one embodiment of the present invention, the polymeric component containing the additive of the present invention can also contain reclaim polymer, such as polymeric scraps collected from the trimmings of previously formed spunbond webs and particularly bicomponent webs.

A further advantage to the crimp enhancement additive of the present invention is that the

additive permits the formation of very fine multicomponent filaments having a relatively high natural crimp. In the past, it was very difficult to create fine filaments, such as at less than 2 denier, that had a relatively high natural crimp. In the past, the draw force used to produce fine fibers usually prevented or removed any meaningful latent crimp present within the filaments. Filaments made according to the present invention, on the other hand, can have greater than 10 crimps per inch at less than 2 denier, and even lower than 1.2 denier.

Besides the above-listed advantages, it has also been discovered that the crimp enhancement additive of the present invention improves thermal bonding between the filaments. In particular, the crimp enhancement additive has a broad melting point range and has a relatively low melt temperature, which facilitates bonding.

The webs and fabrics of the present invention are particularly useful for making various products including liquid and gas filters, personal care articles and garment materials. Personal care articles include infant care products such as disposable baby diapers, child care products such as training pants, and adult care products such as incontinence products and feminine care products. Suitable garments include medical apparel, work wear, and the like.

As described above, the fabric of the present invention includes continuous multicomponent

polymeric filaments comprising at least first and second polymeric components. A preferred embodiment of the present invention is a polymeric fabric including continuous bicomponent filaments comprising a first polymeric component A and a second polymeric component B. The bicomponent filaments have a cross-section, a length, and a peripheral surface. The first and second components A and B are arranged in substantially distinct zones across the cross-section of the bicomponent filaments and extend continuously along the length of the bicomponents filaments. The second component B constitutes at least a portion of the peripheral surface of the bicomponent filaments continuously along the length of the bicomponent filaments.

The first and second components A and B are arranged in either a side-by-side arrangement as shown in FIG. 2A or an eccentric sheath/core arrangement as shown in FIG. 2B so that the resulting filaments exhibit a natural helical crimp. Polymer component A is the core of the filament and polymer component B is the sheath in the sheath/core arrangement. Methods for extruding multicomponent polymeric filaments into such arrangements are well-known to those of ordinary skill in the art.

A wide variety of polymers are suitable to practice the present invention including polyolefins (such as polyethylene and polypropylene), polyesters, polyamides, and the

like. Polymer component A and polymer component B must be selected so that the resulting bicomponent filament is capable of developing a natural helical crimp. Preferably, polymer component A has a faster  
5 solidification rate than polymer component B. For instance, in one embodiment, polymer component A can have a higher melting temperature than polymer component B.

Preferably, polymer component A comprises  
10 polypropylene or a random copolymer of propylene and ethylene. Besides containing polypropylene, polymer component A can also be a nylon or a polyester.

Polymer component B, on the other hand,  
15 preferably comprises polyethylene or a random copolymer of propylene and ethylene. Preferred polyethylenes include linear low density polyethylene and high density polyethylene.

Suitable materials for preparing the  
20 multicomponent filaments of the present invention include PD-3445 polypropylene available from Exxon of Houston, Tex., random copolymer of propylene and ethylene available from Exxon, ASPUN 6811A and 2553 linear low density polyethylene available from the  
25 Dow Chemical Company of Midland, Mich., 25355 and 12350 high density polyethylene available from the Dow Chemical Company.

When polypropylene is component A and  
polyethylene is component B, the bicomponent  
30 filaments may comprise from about 20 to about 80% by weight polypropylene and from about 20 to about

80% polyethylene. More preferably, the filaments comprise from about 40 to about 60% by weight polypropylene and from about 40 to about 60% by weight polyethylene.

5 As described above, the crimp enhancement additive of the present invention is a random copolymer of butylene and propylene and is added to polymer component B which is preferably polyethylene. The butylene-propylene random  
10 copolymer preferably contains from about 5% to about 20% by weight butylene. For instance, one commercially available product that may be used as the crimp enhancement additive is Product No. DS4D05 marketed by the Union Carbide Corporation of  
15 Danbury, Connecticut. Product No. DS4D05 is a butylene-propylene random copolymer containing 14% by weight butylene and 86% by weight propylene. Preferably, the butylene-propylene copolymer is a film grade polymer having an MFR (melt flow rate)  
20 of from about 3.0 to about 15.0, and particularly having a MFR of from about 5 to about 6.5.

In order to combine the crimp enhancement additive with polymer component B, in one  
25 embodiment, the polymers can be dry blended and extruded together during formation of the multicomponent filaments. In an alternative embodiment, the crimp enhancement additive and polymer component B which can be, for instance, polyethylene, can be melt blended prior to being  
30 formed into the filaments of the present invention.

In general, the crimp enhancement additive can be added to polymeric component B in an amount less than 10% by weight. When polymeric component B contains polyethylene, preferably the crimp enhancement additive is added in an amount from about 0.5% to about 5% by weight based upon the total weight of polymer component B. Should too much of the butylene-propylene random copolymer be added to the polymer component, the resulting filaments may become too curly and adversely interfere with the formation of a nonwoven web.

It is believed that the butylene-propylene random copolymer, when added to a polymer such as polyethylene, slows the solidification rate and the crystallization rate of the polymer. In this manner, a greater difference in solidification rates is created between the different polymer components used to make the filaments, thereby increasing the latent crimpability of the filaments.

In an alternative embodiment of the present invention, besides adding the crimp enhancement additive to polymer component B, reclaimed and recycled polymers are also added to the polymer component. As described above, it has been discovered that the crimp enhancement additive of the present invention also facilitates homogeneous mixing between polymers. Specifically, the butylene-propylene random copolymer has been found to facilitate mixing between polyethylene and a reclaim polymer that contains a mixture of



polyethylene and polypropylene. In this embodiment, the reclaim polymer can be added to the polymeric component in an amount up to about 20% by weight. Preferably, the reclaim polymer is collected from scraps and trimmings of previously formed nonwoven webs. Being able to recycle such polymers not only decreases the amount of materials needed to make the nonwoven webs of the present invention, but also limits the amount of waste that is produced.

One process for producing multicomponent filaments and nonwoven webs according to the present invention will now be discussed in detail with reference to Figure 1. The following process is similar to the process described in U.S. Patent No. 5,382,400 to Pike et al., which is incorporated herein by reference in its entirety.

Turning to FIG. 1, a process line 10 for preparing a preferred embodiment of the present invention is disclosed. The process line 10 is arranged to produce bicomponent continuous filaments, but it should be understood that the present invention comprehends nonwoven fabrics made with multicomponent filaments having more than two components. For example, the fabric of the present invention can be made with filaments having three or four components.

The process line 10 includes a pair of extruders 12a and 12b for separately extruding a polymer component A and a polymer component B. Polymer component A is fed into the respective

extruder 12a from a first hopper 14a and polymer component B is fed into the respective extruder 12b from a second hopper 14b. Polymer components A and B are fed from the extruders 12a and 12b through  
5        respective polymer conduits 16a and 16b to a spinneret 18.

Spinnerets for extruding bicomponent filaments are well-known to those of ordinary skill in the art and thus are not described here in detail.

10       Generally described, the spinneret 18 includes a housing containing a spin pack which includes a plurality of plates stacked one on top of the other with a pattern of openings arranged to create flow paths for directing polymer components A and B  
15       separately through the spinneret. The spinneret 18 has openings arranged in one or more rows. The spinneret openings form a downwardly extending curtain of filaments when the polymers are extruded through the spinneret. For the purposes of the  
20       present invention, spinneret 18 may be arranged to form side-by-side or eccentric sheath/core bicomponent filaments illustrated in FIGS. 2A and 2B.

25       The process line 10 also includes a quench blower 20 positioned adjacent the curtain of filaments extending from the spinneret 18. Air from the quench air blower 20 quenches the filaments extending from the spinneret 18. The quench air can be directed from one side of the  
30       filament curtain as shown FIG. 1, or both sides of the filament curtain.

A fiber draw unit or aspirator 22 is positioned below the spinneret 18 and receives the quenched filaments. Fiber draw units or aspirators for use in melt spinning polymers are well-known as discussed above. Suitable fiber draw units for use in the process of the present invention include a linear fiber aspirator of the type shown in U.S. Pat. No. 3,802,817 and educative guns of the type shown in U.S. Patent Nos. 3,692,618 and 3,423,266, the disclosures of which are incorporated herein by reference.

Generally described, the fiber draw unit 22 includes an elongate vertical passage through which the filaments are drawn by aspirating air entering from the sides of the passage and flowing downwardly through the passage. A heater or blower 24 supplies aspirating air to the fiber draw unit 22. The aspirating air draws the filaments and ambient air through the fiber draw unit.

An endless foraminous forming surface 26 is positioned below the fiber draw unit 22 and receives the continuous filaments from the outlet opening of the fiber draw unit. The forming surface 26 travels around guide rollers 28. A vacuum 30 positioned below the forming surface 26 where the filaments are deposited draws the filaments against the forming surface.

The process line 10 further includes a bonding apparatus such as thermal point bonding rollers 34 (shown in phantom) or a through-air bonder 36. Thermal point bonders and through-air bonders are

well-known to those skilled in the art and are not disclosed here in detail. Generally described, the through-air bonder 36 includes a perforated roller 38, which receives the web, and a hood 40 surrounding the perforated roller. Lastly, the process line 10 includes a winding roll 42 for taking up the finished fabric.

To operate the process line 10, the hoppers 14a and 14b are filled with the respective polymer components A and B. Polymer components A and B are melted and extruded by the respective extruders 12a and 12b through polymer conduits 16a and 16b and the spinneret 18. Although the temperatures of the molten polymers vary depending on the polymers used, when polypropylene and polyethylene are used as components A and B respectively, the preferred temperatures of the polymers when extruded range from about 370° to about 530° F. and preferably range from 400° to about 450° F.

As the extruded filaments extend below the spinneret 18, a stream of air from the quench blower 20 at least partially quenches the filaments to develop a latent helical crimp in the filaments. The quench air preferably flows in a direction substantially perpendicular to the length of the filaments at a temperature of about 45° to about 90° F. and a velocity of from about 100 to about 400 feet per minute.

After quenching, the filaments are drawn into the vertical passage of the fiber draw unit 22 by a flow of a gas, such as air, from the heater or

blower 24 through the fiber draw unit. The fiber draw unit is preferably positioned 30 to 60 inches below the bottom of the spinneret 18. The temperature of the air supplied from the heater or blower 24 is sufficient to activate the latent crimp. The temperature required to activate the latent crimp of the filaments ranges from about 60° F. to a maximum temperature near the melting point of the lower melting component which is the second component B.

The actual temperature of the air being supplied by heater or blower 24 generally will depend upon the linear density of the filaments being produced. For instance, it has been discovered that at greater than 2 denier, no heat is required at the fiber draw unit 22 in order to naturally crimp the filaments, which is a further advantage of the present invention. In the past, air being supplied to the fiber draw unit 22 typically had to be heated. Filaments finer than about 2 denier made according to the present invention, however, generally will need to be contacted with heated air in order to induce natural crimping.

The temperature of the air from the heater 24 can be varied to achieve different levels of crimp. Generally, a higher air temperature produces a higher number of crimps. The ability to control the degree of crimp of the filaments is particularly advantageous because it allows one to change the resulting density, pore size

distribution and drape of the fabric by simply adjusting the temperature of the air in the fiber draw unit.

5       The crimped filaments are deposited through the outlet opening of the fiber draw unit 22 onto the traveling forming surface 26. The vacuum 20 draws the filaments against the forming surface 26 to form an unbonded, nonwoven web of continuous filaments. In the past, the web was then typically  
10       lightly compressed by a compression roller and then thermal point bonded by rollers 34 or through-air bonded in the through-air bonder 36. As described above, however, it has been discovered that nonwoven webs made according to the present  
15       invention have increased strength and integrity when containing the crimp enhancement additive. As such, very little prebonding by a compression roller or any other type of prebonding station is necessary in process line 10 prior to feeding the  
20       webs to a bonding station. Further, due to the increased strength of nonbonded webs made according to the present invention, line speeds can be increased. For instance, line speeds can range from about 150 feet per minute to about 500 feet  
25       per minute.

      In the through-air bonder 36 as shown in Figure 1, air having a temperature above the melting temperature of component B and below the melting temperature of component A is directed from  
30       the hood 40, through the web, and into the perforated roller 38. The hot air melts the lower

melting polymer component B and thereby forms bonds between the bicomponent filaments to integrate the web. When polypropylene and polyethylene are used as polymer components A and B respectively, the air flowing through the through-air bonder preferably has a temperature ranging from about 230° to about 280° F. and a velocity from about 100 to about 500 feet per minute. The dwell time of the web in the through-air bonder is preferably less than about 6 seconds. It should be understood, however, that the parameters of the through-air bonder depend on factors such as the type of polymers used and thickness of the web.

Lastly, the finished web is wound onto the winding roller 42 and is ready for further treatment or use. When used to make liquid absorbent articles, the fabric of the present invention may be treated with conventional surface treatments or contain conventional polymer additives to enhance the wettability of the fabric. For example, the fabric of the present invention may be treated with polyalkylene-oxide modified siloxanes and silanes such as polyalkylene-oxide modified polydimethyl-siloxane as disclosed in U.S. Pat. No. 5,057,361. Such a surface treatment enhances the wettability of the fabric.

When through-air bonded, the fabric of the present invention characteristically has a relatively high loft. The helical crimp of the filaments creates an open web structure with substantial void portions between filaments and the

filaments are bonded at points of contact. The through-air bonded web of the present invention typically has a density of from about 0.015 g/cc to about 0.040 g/cc and a basis weight of from about 0.25 to about 5 oz. per square yard and more preferably from about 1.0 to about 3.5 oz. per square yard.

Filament linear density generally ranges from less than 1.0 to about 8 denier. As discussed above, the crimp enhancement additive of the present invention allows for the production of highly crimped, fine filaments. In the past, naturally crimped fine filaments were difficult if not impossible to produce. According to the present invention, filaments having a natural crimp of at least about 10 crimps per inch can be produced at linear densities less than 2 denier, and particularly at less than about 1.2 denier. For most nonwoven webs, it is preferable for the filaments to have from about 10 crimps per inch to about 25 crimps per inch. Of particular advantage, filaments having a natural crimp in the above range can be produced according to the present invention at a lower linear density than what has been possible in the past.

Thermal point bonding may be conducted in accordance with U.S. Pat. No. 3,855,046, the disclosure of which is incorporated herein by reference. When thermal point bonded, the fabric of the present invention exhibits a more cloth-like appearance and, for example, is useful as an outer



cover for personal care articles or as a garment material.

Although the methods of bonding shown in FIG. 1 are thermal point bonding and through-air bonding, it should be understood that the fabric of the present invention may be bonded by other means such as oven bonding, ultrasonic bonding, hydroentangling or combinations thereof. Such bonding techniques are well-known to those of ordinary skill in the art and are not discussed here in detail.

Although, the preferred method of carrying out the present invention includes contacting the multicomponent filaments with aspirating air, the present invention encompasses other methods of activating the latent helical crimp of the continuous filaments before the filaments are formed into a web. For example, the multicomponent filaments may be contacted with air after quenching but upstream of the aspirator. In addition, the multicomponent filaments may be contacted with air between the aspirator and the web forming surface. Furthermore, the filaments may also be exposed to electromagnetic energy such as microwaves or infrared radiation.

Once produced, the nonwoven webs of the present invention can be used in many different and various applications. For instance, the webs can be used in filter products, in liquid absorbent products, in personal care articles, in garments, and in various other products.

The present invention may be better understood with reference to the following Examples.

Example No. 1

The following Example was conducted in order to compare the differences between filaments and nonwoven webs made with the crimp enhancement additive of the present invention and filaments and nonwoven webs constructed without the crimp enhancement additive.

Two bicomponent spunbond fabrics were produced generally in accordance with the process disclosed in US Patent 5,382,400 (Pike, et al). In both fabrics, the filaments were round in cross section with the two components arranged in a side-by-side configuration. One side of the filaments was made primarily of polypropylene (Exxon 34455), while the other side was made primarily of polyethylene (Dow 61800). In both fabrics, the polypropylene (PP) side contained in an amount of 2% by weight an additive composed of 50% polypropylene and 50%  $\text{TiO}_2$ .

In the first fabric (Fabric A), in accordance with the present invention, the polyethylene (PE) side contained in an amount of 2% by weight a random copolymer of 14% butylene and 86% propylene (Union Carbide DS4D05). The polyethylene side of the other fabric (Fabric B), on the other hand, was 100% polyethylene.

Both fabrics were produced at a total polymer throughput of 0.35 ghm of polymer per hole at a hole density of 48 holes per inch of width and were through air bonded at an air temperature of 265° F.

Fabric A was produced at a line speed of 44 feet per minute, while Fabric B was produced at 37 feet per minute. Line speed was used to control basis weight, all other process conditions remained the same. Both fabrics had a basis weight of 2.6 ounces per square yard (osy).

The fabrics were tested for tensile peak load, peak strain and peak energy (3" strips) in both the machine direction (MD) and cross-machine direction (CD) according to ASTM D-5035-90 and for caliper under a load of 0.05 psi with a Starrett-type caliper tester. Fabric density was calculated from basis weight and caliper. Fiber crimp was rated on a subjective 1 to 5 scale with 1 = no crimp and 5 = very high crimp. Fiber linear density was calculated from the diameter of the filaments (measured by microscope) and the density of the polymer. The strength of the unbonded web was determined by collecting a length of fabric that had not yet entered the bonder and gently laying it on the floor. The fabric was then slowly and gently lifted by one end until tensile failure was noted. The length of the fabric that was lifted at the point of tensile failure was recorded as the breaking length of the unbonded web.

The test results are shown on the following table.

Properties of Fabrics A & B

		<u>Fabric A</u>	<u>Fabric B</u>
	Filament Linear Density (denier)	1.3	1.3
	Filament Crimp Index	4.0	1.0
5	Fabric Basis Weight (osy)	2.6	2.6
	Fabric Caliper (in)	0.135	0.090
	Fabric Density (g/cc)	0.026	0.038
	Unbonded Fabric Tensile		
	Breaking Length (in)	66	18
10	Bonded Fabric Tensile Properties:		
	MD Peak Load (lb)	6.5	10.9
	MD Peak Strain (%)	46	20
	MD Peak Energy (in-lb)	4.7	4.4
	CD Peak Load (lb)	10.6	22.3
15	CD Peak Strain (%)	138	66
	CD Peak Energy (in-lb)	24	32

The results show that Fabric A, relative to  
 Fabric B, is composed of filaments having greater  
 20 crimp and has a greater caliper (and therefore,  
 lower density). . . Fabric A further has much greater  
 unbonded web strength. While the tensile peak  
 loads of Fabric B are about twice as large as those  
 of Fabric A, the peak strain values of Fabric A are  
 25 greater than those of Fabric B by about the same  
 factor. Fabric peak energies, particularly in the  
 machine direction, are similar.

Of particular significance, it is noted that  
 the linear densities of both sets of filaments were  
 30 very low, at about 1.3 denier. As shown, the  
 filaments made containing the crimp enhancement

additive of the present invention had a high natural crimp while the filaments not containing the additive experienced no significant crimp. As described above, in the past, it was very difficult to create a naturally crimped filament at low linear densities.

Example No. 2

The following example was conducted in order to demonstrate the ability of the additive of the present invention to facilitate mixing between different polymeric materials.

Polyethylene/polypropylene bicomponent filaments were produced and formed into a spunbond nonwoven web generally in accordance with the process described in Example 1 and disclosed in U.S. Patent No. 5,382,400 to Pike, et al.. The polyethylene side of the bicomponent filaments contained 20% by weight reclaim polymer. Specifically, the reclaim polymer was a mixture of polypropylene and polyethylene that had been collected from the trimmings of a previously formed nonwoven web.

In accordance with the present invention, the polyethylene component also contained 5% by weight of the butylene/propylene random copolymer identified in Example 1.

It was observed that by adding the butylene/propylene copolymer of the present invention, the reclaim polymer readily blended with the polyethylene component and produced a polymeric material that could be spun into filaments, which,

in turn, could be naturally crimped. Further, it was discovered that filaments with very low linear densities could be produced. For instance, at a polymer throughput of 0.4 ghm and at a fiber draw pressure of 7.4 psi, filaments were produced having a linear density of 1.18 denier.

In the past, attempts have been made to produce bicomponent filaments containing reclaim polymer. Absent adding the additive of the present invention, however, it was not possible to spin the polymer mixture into filaments.

These and other modifications and variations to the present invention may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention, which is more particularly set forth in the appended claims. In addition, it should be understood that aspects of the various embodiments may be interchanged both in whole or in part.

Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and is not intended to limit the invention so further described in such appended claims.

WHAT IS CLAIMED IS:

1. A process for forming a nonwoven web comprising the steps of:

5 melt spinning multicomponent filaments, said filaments comprising a first polymeric component and a second polymeric component, said first polymeric component having a faster solidification rate than said second polymeric component, said second polymeric component containing a butylene-propylene copolymer;

10 drawing said multicomponent filaments; naturally crimping said multicomponent filaments; and

thereafter forming said multicomponent filaments into a nonwoven web.

2. A process as defined in claim 1, wherein said second polymeric component comprises polyethylene.

3. A process as defined in claim 1, wherein said butylene-propylene copolymer comprises a random copolymer containing up to about 20% by weight butylene.

4. A process as defined in claim 1, wherein said butylene-propylene copolymer is added to said second polymeric component in an amount up to about 10 percent by weight.

5. A process as defined in claim 1, wherein said butylene-propylene copolymer is added to said second polymeric component in an amount from about 0.5% to about 5% by weight.

6. A process as defined in claim 2, wherein said first polymeric component comprises polypropylene.

7. A process as defined in claim 2, wherein said first polymeric component comprises a material selected from the group consisting of nylon, polyester and propylene-ethylene copolymers.

8. A process as defined in claim 1, wherein said second polymeric component further comprises reclaimed polymers, said reclaimed polymers comprising polypropylene, polyethylene or copolymers of propylene and ethylene.

9. A process as defined in claim 1, wherein said multicomponent filaments have a linear density of less than about 2 denier.

10. A process for forming a nonwoven web comprising the steps of:

melt spinning bicomponent filaments, said bicomponent filaments comprising a first polymeric component and a second polymeric component, said first polymeric component comprising polypropylene, said second polymeric component comprising a mixture of polyethylene and a butylene-propylene copolymer;

drawing said bicomponent filaments; crimping said bicomponent filaments; and thereafter forming said bicomponent filaments into a nonwoven web.

11. A process as defined in claim 10, wherein said bicomponent filaments are crimped by subjecting said filaments to a flow of a gas.



12. A process as defined in claim 10, wherein said butylene-propylene copolymer is present in said second polymeric component in an amount from about 0.5% to about 5% by weight.

13. A process as defined in claim 12, wherein said butylene-propylene copolymer comprises a random copolymer containing about 14% by weight butylene.

14. A process as defined in claim 10, wherein said second polymeric component further comprises reclaimed polymers, said reclaimed polymers comprising polypropylene, polyethylene or copolymers of propylene and ethylene.

15. A process as defined in claim 14, wherein said reclaimed polymers are present in said second polymeric component in an amount up to about 20% by weight.

16. A process as defined in claim 10, wherein said bicomponent filaments have a linear density of less than about 2 denier.

17. A process as defined in claim 10, wherein said crimped bicomponent filaments contain at least 10 crimps per inch.

18. A nonwoven web comprising spunbond multicomponent crimped filaments, said multicomponent crimped filaments being made from at least a first polymeric component and a second polymeric component, said first polymeric component having a faster solidification rate than said second polymeric component, said second polymeric

component containing a butylene-propylene random copolymer.

19. A nonwoven web as defined in claim 18, wherein said second polymeric component comprises polyethylene.

20. A nonwoven web as defined in claim 19, wherein said butylene-propylene random copolymer is present within said second polymeric component in an amount up to about 5% by weight.

21. A nonwoven web as defined in claim 20, wherein said first polymeric component comprises polypropylene.

22. A nonwoven web as defined in claim 21, wherein said butylene-propylene random copolymer contains up to about 20% by weight butylene.

23. A nonwoven web as defined in claim 22, wherein said multicomponent crimped filaments have a linear density of less than about 2 denier.

24. A naturally crimped bicomponent filament comprising at least a first polymeric component and a second polymeric component, said first polymeric component having a faster solidification rate than  
5 said second polymeric component, said filament containing a crimp enhancement additive, said crimp enhancement additive being added in an amount sufficient for said filament to have at least 10  
10 crimps per inch, said multicomponent filament having a linear density of less than about 2 denier.

25. A naturally crimped multicomponent filament as defined in claim 24, wherein said

filament has a linear density of less than about 1.2 denier.

26. A naturally crimped multicomponent filament as defined in claim 24, wherein said second polymeric component comprises polyethylene and wherein said crimp enhancement additive  
5 comprises a butylene-propylene random copolymer and is contained within said second polymeric component.

27. A naturally crimped multicomponent filament as defined in claim 26, wherein said first polymeric component comprises polypropylene.

28. A process for improving the unbonded strength of a spunbond nonwoven web, said process comprising the steps of:

incorporating into a first polymeric  
5 component a butylene-propylene copolymer;  
melt spinning multicomponent filaments from said first polymeric component and at least a second polymeric component;  
drawing said multicomponent filaments;  
10 and

thereafter forming said multicomponent filaments into a nonwoven web wherein said butylene-propylene copolymer is present in said web in an amount sufficient to increase the strength of  
15 said web prior to being thermally bonded.

29. A process as defined in claim 28, wherein said butylene-propylene copolymer is added to said first polymeric component in an amount from about 0.5% to about 5% by weight.

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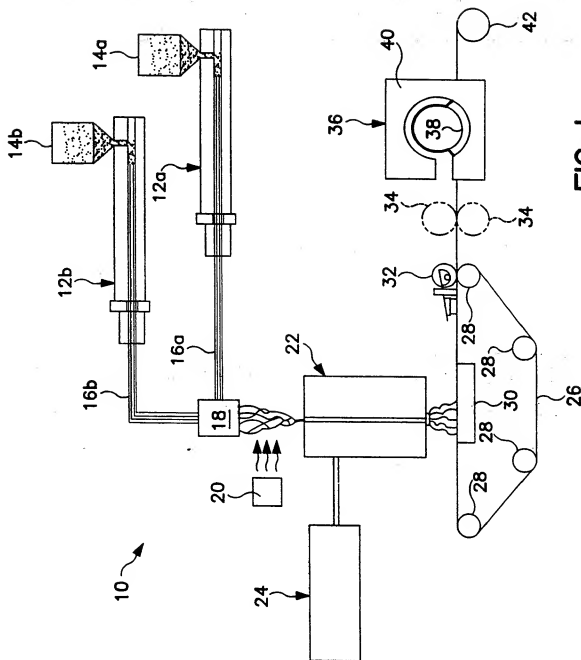


FIG. 1

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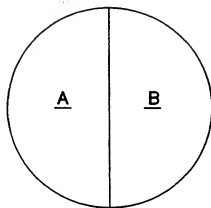


FIG. 2A

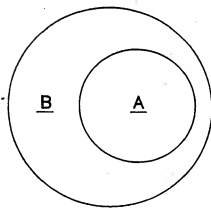


FIG. 2B

## INTERNATIONAL SEARCH REPORT

 International Application No  
 PCT/US 98/20539

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 D01F8/06 D02G1/18 D02G3/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 D01F D02G D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of box C

☒ Patent family members are listed in annex

## \* Special categories of cited documents

\*A\* document defining the general state of the art which is not considered to be of particular relevance

\*E\* earlier document but published on or after the international filing date

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\*O\* document referring to an oral disclosure, use, exhibition or other means

\*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

\*Z\* document member of the same patent family

Date of the actual completion of the international search

2 February 1999

Date of mailing of the international search report

15/02/1999

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## INTERNATIONAL SEARCH REPORT

International Application No

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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